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(54) [TITLE OF THE INVENTION]
MAIN BODY OF HOLLOW LIGHT GUIDE PLATE AND HOLLOW LIGHT GUIDE PLATE USING THE SAME
[Chukuu dokoban hontai oyobi sore o mochiita chuukuu dokoban]

[Amendments: Attached amendments on the description of Figures and codes are incorporated to the text of translation. Translator's note]

[Note: All names, addresses, company names, and brand names are translated in the most common manner. Japanese language does not have singular or plural words unless otherwise specified with numeral prefix or general form of plurality suffix. Translator's note]

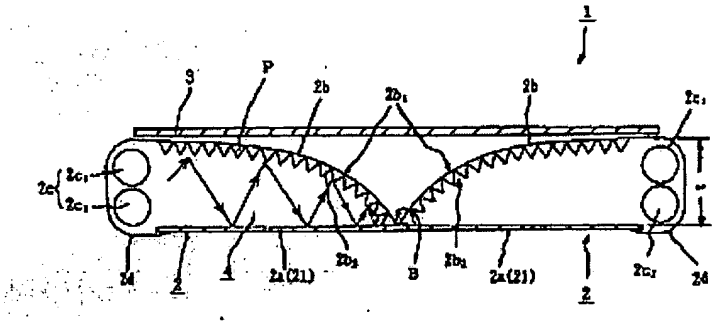
(57) [ABSTRACT]

[PURPOSE]

It offers a light weight main body of hollow light guide plate capable of discharging lights with high luminance and high uniformity; and a hollow light guide plate using the same.

[CONSTITUTUION]

A flat reflective layer of lights (2a) and a light discharging layer (2b) that is smoothly curved in a single axis direction are arranged in such manner so the reflective layer of lights (2a) and the light discharging layer (2b) would be opposite to each other at one end side of said curved axis while the reflective layer of lights (2a) and the light discharging layer (2b) nay come in contact at the other end side via a layer of air (4), and at the same time, a light source (2c) is arranged at the end part of layer of air (4) where above-explained reflective layer of lights (2a) and the light discharging layer (2b) are opposite to each other in a linear manner in almost perpendicular direction to a plane that includes above-explained curved axis; and above-explained light discharging layer (2b) is structured of a flexible light-transmitting sheet (22) comprising continuous prism concave/convex planes (2b2) of which outer plane is of a flat and smooth plane (2b1) and inner plane that faces the reflective layer of lights (2a) having multiple numbers of prism bodies (P) that are arranged in parallel lines having each main axis in almost right angle to above-explained curved axis.



[CLAIMS]

[CLAIM ITEM 1]

The main body of hollow light guide plate is characterized by the fact that is formed by an arrangement of a flat reflective layer of lights and a light discharging layer that is smoothly curved in a single axis direction in a manner so the reflective layer of lights and the light discharging layer would be opposite to each other at one end side of said curved axis while light discharging layer may come in contact with the reflective layer of lights at the other end side via a layer of air, and at the same time, a light source is arranged at end part of the layer of air that is at the side where above-explained reflective layer of lights and the light discharging layer are opposite to each other in a linear manner in almost perpendicular direction to the plane that includes above-explained curved axis; and above-explained light discharging layer is structured of a flexible light-transmitting sheet comprising continuous prism concave/convex planes of which outer plane is of a flat and smooth plane and inner plane that faces reflective layer of lights has multiple numbers of prism bodies that are arranged in parallel lines while having each main axis in almost right angle to above-explained curved axis.

[CLAIM ITEM 2]

The main body of hollow light guide plate that is described in the claim item 1, wherein vertical angle of each prism body that constitutes concave part of continuous prism concave/convex planes is $70 \sim 110^{\circ}$.

[CLAIM ITEM 3]

The main body of hollow light guide plate that is described in claim items of either 1 or 2, wherein said reflective layer of lights is formed of a light reflective sheet and a light scattering layer that is formed through attachment of multiple numbers of light scattering dots to said light reflective sheet; and light scattering dots are adjusted for their spectral density based on the curvature variation of the light discharging layer.

[CLAIM ITEM 4]

A hollow light guide plate comprising through arrangement of two main bodies of hollow light guide plates that are described in any one of the claim items of 1~ 3 in right/left symmetrical manner so each light source would be positioned at both ends to allow mutual contact of connecting lines of light discharging layer and reflective layer of lights of each main body of hollow light guide plate, and at the same time, each reflective layer of lights is linked to form a identical flat plane.

[CLAIM ITEM 5]

The hollow light guide plate that is described in the claim item 4, wherein said light scattering layer is arranged as almost parallel to the reflective layer of lights at outer side of the light discharging layer.

[DETAILED EXPLANATIUON OF THIS INVENTION]

[0001]

[FIELDS OF INDUSTRIAL APPLICATION]

This invention relates to the main body of hollow light guide plate, and the hollow light plate that uses the same. In further detail, it relates to the light guide plate for a back light of various plane illumination device, or in particular, the main body of hollow light guide plate of a side light method type suitable for display devices using liquid crystal, and hollow light guide plate.

[0002]

[PRIOR ART]

Display devices using liquid crystal has been commercialized to replace conventional cathode ray tubes due to its established reputation of low electrical power and thin type; and in particular, it has been attracting much attention as a large-size screen display device. According to such type of liquid crystal display device, it requires a light guide plate for a back light purpose that illuminates liquid crystal from its back plane to make it visible because liquid crystal itself does not emit lights. Regarding above-explained light guide plate, for instance, the ones that utilize a so-called edge lighting technology by making lights to enter from aside plane of a light-transmitting flat sheet (acryl sheet) and discharges lights from a large flat plane have been widely used; and these are generally structured of a solid body.

[0003]

Incidentally, liquid crystal display device shows a trend toward increase in size; and light guide plate of large size is required along with such trend to present a problem of increase in weight along with this size increase; and reduction of weight through structuring the light guide plate as a hollow body has been attempted to counter against this. As one such example of this, the one of which light-transmitting flat sheet is structured as a hollow structure to be used as a hollow light guide base body and reflective layer of lights is formed on one of the two large planes of this base while light discharging plane is formed on the other plane may be mentioned.

[0004]

However, according to such hollow light guide plate, light discharging side of hollow light guide plate base has a flat plane on both outer plane as well as inner plane, and lights that are introduced from a side edge plane are made to reflect between reflective layer of lights and flat plane of inner plate of light discharging plane side and to refract at light discharging plane side in repeated manner to guide them into said base to emit lights; however, lights are transmitted through the base at nearby light source and are discharged to cause diffusion and attenuation in the direction toward light guide, and it is not possible to anticipate discharged lights with high luminance in addition to also causing uneven luminance.

[0005]
On the one hand, as a plane light source element, for instance, the one that jointly uses a light-transmitting sheet of which one plane is formed of a flat plane and the other of group of prisms as a side light type solid light guide plate and flat plane of this light-transmitting sheet is arranged so it would be opposite to the light discharging plane of above-explained solid light guide plate has been known. (Make reference to a publication of the Japanese patent application Tokkai [laid-open] Hei 2 [1990]-84618.) However, above-explained light-transmitting sheet is not a constitutional element of the light guide plate, and furthermore, it is arranged in parallel to the light discharging plane of light guide plate to convert discharging direction from said light discharging plane to a normal direction; and as a result, this plane light source element provides high luminance on visual angle range in the specific direction only.

[0006]
[SUBJECTS SOLVED BY THIS INVENTION]
And therefore, the subject that is intended to be solved by this invention is to offer a main body of light weight hollow light guide plate capable of discharging lights with high luminance and high uniformity and a hollow light guide plate using the same.

[0007]
[MEANS USED TO SOLVE THE SUBJECTS]
According to the "claim item 1" of this patent application, it offers " the main body of hollow light guide plate (2) that is characterized by the fact that is formed by an arrangement of a flat reflective layer of lights (2a) and a light discharging layer (2b) that is smoothly curved in a single axis direction in a manner so the reflective layer of lights (2a) and light discharging layer (2b) would be opposite to each other at one end side of said curved axis while light discharging layer (2b) may come in contact with reflective layer of lights (2a) at the other end side via layer of air, and at the same time, a light source (2c) is arranged at end part of the layer of air that is at the side where above-explained reflective layer of lights and light discharging layer are opposite to each other in a linear manner in almost perpendicular direction to the plane that includes above-explained curved axis; and above-explained light discharging layer (2b) is structured of a flexible light-transmitting sheet (22) comprising continuous prism concave/convex planes of which outer plane (2b1) is of a flat and smooth plane and inner plane that faces reflective layer of lights (2a) has multiple numbers of prism bodies (P) that are arranged in parallel lines while having each main axis in almost right angle to above-explained curved axis

[0008]
According to the main body of hollow light guide plate (2) of this invention, the light discharging layer (2b) constitutes of a flexible light-transmitting sheet (22). As this light-transmitting sheet (22), the one that is structured having one plane (2b1) as a flat and smooth plane while other plane is of continuous prism concave/convex planes on which multiple number of prism bodies (P) of which each main axis is arranged in parallel lines is used. Above-explained light-transmitting sheet (22) is used in a manner by having its flat and smooth plane being at outer plane side of the main body of light guide plate and continued prism concave/convex plane faces against reflective layer of lights (2a) at inside of the main body of light guide plate. Furthermore, above-explained light-transmitting sheet (22) is used by smoothly curving in a single axis direction; and at this time, the main axis of each prism body (P) on the continued prism concave/convex planes is set in almost right angle direction to the curved axis. Through this, axis of light source that is arranged in a linear form and the main axis of each prism are arranged in either parallel or almost twisted form to enable to reflect, refract, and transmit direct lights from the light source or reflected lights from the reflective layer of lights (2a). As above-explained light-transmitting sheet (22), the one that is made of polycarbonate is favorable from the standpoint of strength, light transmission, or refractive property and the like, and the one that is made of acryl copolymer resin is also used favorably, but it should not be specifically limited to these.

[0009]
Above-explained light discharging layer (2b) is arranged in such manner that it is opposite to the reflective layer of lights (2a) at nearby light source (2c), in other words, at one end part of the main body of hollow light guide plate (2), and is smoothly curved toward reflective layer of lights (2a) as it positions itself far away position from the light source (2c).

[0010]
According to the main body of hollow light guide plate (2) of this invention, it is possible to quantitatively control the rate of discharged lights and that of reflected lights through adjustment of the curvature of curved part of above-explained light-transmitting sheet (22) and size of each prism body (P) that constitute the light discharging layer (2b).

[0011]
As described in the "claim item 2" of this patent application, it is preferable when vertical angle (θ) of each prism body that constitutes continued prism concave/convex planes of said sheet is adjusted to the range of $70 \sim 110^{\circ}$ from the standpoint of high luminance and high uniformity regarding the light-transmitting sheet (22) that constitutes above-explained light discharging layer (2b).

[0012]
The light source (2c) that is arranged in linear manner on the main body of hollow light guide plate (2) of this invention may use linear light source as well as the one on which multiple numbers of dot-form light sources are lined in linear manner. It is preferable when linear-form light source is used in this invention, and fluorescent lamp or cathode ray discharging tube and the like may be mentioned; and the latter is further preferable from the standpoint of its large amount of light per unit length and generating hardly any heat.

[0013]
Although reflective layer of lights (2a) may use light reflective sheets that are already known in said field as they are, reflective layer having free electrons such as thin film and the like caused by aluminium foil or silver mirror reaction and the like does accompany heat generation though it may be slight, and is not desirable, and white plastic sheet (21) is used favorably. Regarding further preferred format of reflective layer of lights (2a), as described in the "Claim item 3" of this patent application, the one that constitutes of above-explained light reflective sheet (21) and light scattering layer (2A) by multiple number of light scattering dots (23), and density of light scattering dots (23) is adjusted based on variation of the curvature of the light discharging layer (2b) and is attached to the light reflective sheet may be mentioned; and this is very favorable from the standpoint of high luminance and high uniformity. As above-explained light scattering layer, the one that is prepared by mixing light scattering inorganic substance in a transparent resin to adjust a light-scattering ink, and this is subjected to a dot gradation pattern printing in accordance with the curvature and the like of light discharging layer is preferable; however, it should not be limited to this, and the light reflective sheet that is prepared by directly treating a coarse plane with each light scattering dot itself in above-explained dot gradation pattern may be also mentioned.

[0014]
As described in the "Claim item 4" , the invention of this patent application is also capable of offering a hollow light guide plate (1) through arrangement of two main bodies of hollow light guide plates (2) of above-explained invention of this patent application in right/left symmetrical manner to position each light source at both ends to allow mutual contact of connecting lines of light discharging layer (2b) and reflective layer of lights (2a) of each main body of hollow light guide plate (2), and at the same time, each reflective layer of lights is lined to form an identical flat plane.

[0015]
As described in the "Claim item 5" of this patent application, according to above-explained hollow light guide plane (1), it is all right when light diffusion layer (3) is arranged at outer side of the light discharging layer (2b) in almost parallel manner to the reflective layer of lights (2a). As above-explained light diffusion layer, the ones that are already known in this field may be used as they are.

[0016]
[ACTIONS]
According to the invention that pertains to the "Claim item 1" of this patent application, majority of the lights irradiated from the light source (2c) are guided in the direction that is far away from the light source within a light guide body by repeating reflection between the reflective layer of lights (2a) and continued prism concave/convex planes of the light discharging layer (2b) that are arranged via layer of air (4). At this time, because straight lights that move in a horizontal direction from the light source (2c) as well as above-explained reflected lights pass through the layer of air (4), lights during this passing [process] are not absorbed and attenuation on the quantity of lights does not occur. In addition, because light discharging layer (2b) curves more smoothly as it becomes further away from the light source (2c) to block the layer of air (4), straight lights enter any one of the prism plane surely and are refracted and discharged, and at the same time, discharged lights of reflected lights are also extended to far away region along with this curving to control discharging of lights at nearby light source while increasing the quantity of discharge lights at far away region from the light source.

[0017]
According to invention of the "Claim item 2" of this patent application, because vertical angle (θ) of each prism body (P) that constitute convex part of continued prism concave/convex planes is set to be $70 \sim 110^{\circ}$, quantity of lights that are guided to far away region increases in addition to becoming uniform.

[0018]
According to the invention of the "Claim item 3" of this patent application, reflective layer of lights (2a) consists of light reflective sheet (21) and light scattering layer (2A) by multiple numbers of light scattering dots (23) that are placed on said light reflective sheet; and because roughness and closeness of the distribution of light scattering dots (23) is adjusted based on the variation of curvature of the light discharging layer (2b), lights that are discharged from the light discharging layer (2b) are made to be more highly uniform.

[0019]
According to the invention of the "Claim item 4" of this patent application, because two main bodies of hollow light guide plates (2) of any claim items of $1 \sim 3$ are arranged in right/left symmetrical manner on the reflective layer of lights (2a) on an identical flat plane, discharging of lights at nearby each light source can be restricted, and at the same time, quantity of discharged lights from each main body of hollow light guide plate (2) is appropriately mixed at the center part to provide high overall uniformity that leads to high luminance.

[0020]
According to the invention of the "Claim item 5" of this patent application, because light diffusion layer(3) is arranged in almost parallel to the reflective layer of lights (2a) at outer side of the light discharging layer (2b), it is possible to prevent from glare on the light discharging plane while maintaining high luminance and high uniformity.

[0021]
[EXAMPLES]
This invention is explained in accordance to the examples illustrated in Figures below; and this invention should not be limited by these.

EXAMPLE 1
Figure 1 illustrates a structural explanatory sectional view of one example of hollow light guide plate of this invention. According to this Figure, a hollow light guide plate (1) is mainly constituted of two main bodies of hollow light guide plates (2), (2) that are arranged in right/left symmetrical manner, and light diffusion plate (3) that is arranged at top part of these main bodies of hollow light guide plates.

[0022]
Each main body of hollow light guide plate (2) constitutes of a flat-sheet form reflective layer of lights (2a), light discharging layer (2b) that descends while smoothly curving in one direction, a linear-form light source (2c), and lamp reflector (2d).

[0023]
The reflective layer of lights (2a) constitutes of white plastic sheet (21); and according to this example, it constitutes of one sheet common to the two main bodies of hollow light guide plates (2).

[0024]
Each light discharging layer (2b) is of a polycarbonate made light-transmitting sheet of which outer plane is flat and smooth plane (2b1) while its inner plane constitutes of continued prism concave/convex planes (2b2) in which multiple numbers of prism bodies (P) are arranged in lines having each main axis in almost right angle to above-explained curving direction. Each prism body (P) on above-explained continued prism concave/convex planes is set to show vertical angle (θ) that is within a range of $70 \sim 110^{\circ}$ as illustrated in the Figure 2. Above-explained light discharging layer (2b) and reflective layer of lights (2a) are arranged via layer of air (4) and according to this main body of hollow light guide plate, and they are made to oppose against each other in almost parallel manner at one end part while light discharging layer (2b) and reflective layer of lights (2a) are made to be in contact at the other end part. Furthermore, a linear-form light source (2c) is arranged at the end part of layer of the air (4) that is at the side of arrangement opposite to each other in almost parallel manner.

[0025]
As linear-form light source (2c), two cold cathode discharge tube (21) (2c2) are used; and they are arranged in almost perpendicular direction as illustrated in the Figure, and at the same time, these 2 discharge tubes are arranged as piled in top/down direction as illustrated in the Figure.

[0026]
The lamp reflector (2d) includes linear-form light sources (2c1), (2c2) inside; and they are arranged to extend from the end part of above-explained reflective layer of lights (2a) to the end part of light discharging layer (2b).

[0027]
Each main body of hollow light guide plate (2), (2) of the hollow light guide plate (1) is arranged in a manner so contact end of each light discharging layer (2b), (2b) on a common reflective layer of lights (2a) would come in mutual contact to enable to form a border line (B).

[0028]
The light diffusion plate (3) is same as those that are used ordinarily in this field; and it is arranged on top part of two main bodies of hollow light guide plates (2), (2) in almost parallel to the reflective layer of lights (2a).

[0029]
The hollow light guide plate (1) that is structured as explained above show arrangement of linear-form light source (2c) at the side of one pair of opposing long side as illustrated with a plane structural explanatory view of the Figure 3; and regarding the size, it is set to be X=230 mm, Y=145 mm, and t=10 mm according to the Figure 1 and Figure 3; but it should not be limited to this.

[0030]
Three types of hollow light guide plates (1A), (1B), and (1C) showing the same structure by changing vertical angle (θ) of prism body to 110°, 90°, and 70° respectively were prepared; and luminance (cd/m^2) on the middle line U illustrated in the Figure 3 of each hollow light guide plate was measured at 5 mm increment from linear-form light source of one side, results shown in the Figure 4 were given. Furthermore, as comparative examples, solid light guide plates of which light discharging planes on a plane view being the same as those of the example were prepared to include i) showing uniform thickness (t=10 mm) [comparative example (1)], ii) showing light discharging plane is of concave plane that is part of cylindrical plane, and the plane that is opposite to this is of a flat plane (maximum thickness t=10 mm) [comparative example (2)], and iii) linked opposing to each other in right/left symmetrical manner showing wedge shape of cross-sectional plane (maximum thickness t=10 mm) [comparative example (3)]; and luminance on each light discharging plane was measured in the same manner as explained in the example. Results are jointly shown in the Table of Figure 4.

[0031]
According to above-explained results, it may be noted that all hollow light guide plates (1A), (1B), and (1C) of this invention show very small mass with large average luminance and excellent uniformity over entire light discharging planes compared to those of comparative examples (1), (2) and (3).

[0032]
EXAMPLE 2
According to the hollow light guide plate (1) of the example 1, the ones showing the same structure except arrangement of light scattering layer (2A) at opposite plane to the light discharging layer of reflective layer of lights (2a) were made; and therefore, the identical members are shown with identical numbers and explanation on these are omitted. The light scattering layer (2A) is prepared of so-called dot gradation printing layer by printing light scattering dots (23) using an ink in which transparent resin, a light scattering inorganic substance (for instance, SiO_2) was mixed, and at the same time, the roughness/closeness of dot distribution was adjusted in accordance with variation of the curvature of light discharging layer (2b) of this time. The dot gradation printing explained above is conducted in a manner so the dot distribution would be rough at the side of light source and it is set to be close as it moves away from the light source, in other words, it would become close in accordance with the curvature.

[0033]
Through arrangement of light scattering layer as explained above, it became possible to obtain a hollow light guide plate of which luminance over entire discharging plane shows further high level of uniformity.

[0034]
[EFFECTS OF THIS INVENTION]
According to this invention, it is possible to offer a side light method type of light guide plate that has a large light discharging plane with large luminance and is capable of discharging lights at uniform luminance. Furthermore, even when it is structured as a large size, it is possible to obtain a very light weight light guide plate through a hollow structure. In addition, the one that has an arrangement of light scattering layer by dot gradation printing can attain further higher level of luminance uniformity, and it can offer a side light type method light guide plate showing larger size and higher quality.

[BRIEF DESCRIPTION OF THE FIGURES]
[FIGURE 1]
It illustrates a sectional structural explanatory view of this invention's hollow light guide plate.

[FIGURE 2]
It illustrates an enlarged schematic view of main parts of the Figure 1.

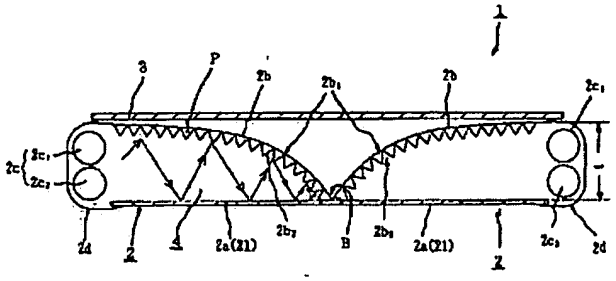
[FIGURE 3]
It illustrates a plane structural explanatory view of the Figure 1.

[FIGURE 4]
It shows a Table of luminance distribution on light discharging planet of this invention's hollow light guide plate along with those of comparative example.

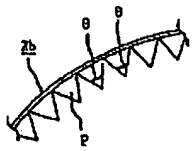
[DESCRIPTION OF CODES]
(1), (1A), (1B), and (1C): hollow light guide plate
(2): main body of hollow light guide plate
(3): light diffusion plate, (4): layer of air, (21): white plastic sheet, (22): light-transmitting sheet , (2A): light scattering layer, (P) prism body, (2a): reflective layer of lights, (2b): light discharging layer, (2c) linear-form light source, (2d): lamp reflector, (2b1): flat smooth plane, (2b2) continued prism concave/convex plane, (2c1), (2c2): cold cathode discharging tube,

[I: Figure, II: [illegible] distance from the light source on U line, III: example, IV: comparative example, V: maximum luminance, VI: minimum luminance, VII: average luminance, VIII: mass]

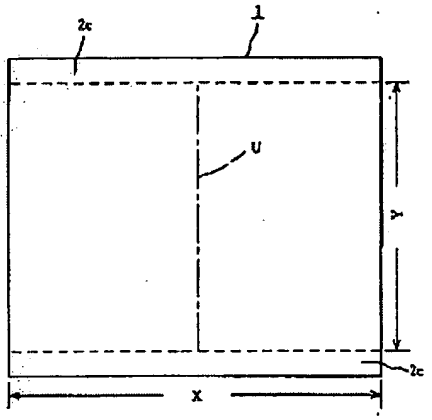
【図1】



【図2】



【図3】



【図4】

	実施例			比較例		
	1A	1B	1C	①	②	③
5	2940	2060	2560	1610	1243	881
10	3340	2350	2740	1920	1602	1389
15	3150	2160	2500	1690	1730	1705
20	3000	2020	2340	2020	1841	1872
25	2900	2040	2330	2040	1985	1980
30	2800	2140	2360	2040	2150	2180
35	2600	2480	2470	2040	2320	2340
40	2650	2730	2670	2040	2430	2490
45	2820	2850	2810	2030	2500	2620
50	2900	2950	2850	2030	2540	2720
55	2740	2980	2840	2030	2540	2810
60	2570	2880	2780	2040	2520	2880
65	2540	2760	2700	2040	2490	2940
70	2670	2560	2550	2040	2470	2980
75	2710	2380	2470	2030	2440	3010
80	2610	2380	2570	2020	2450	3010
85	2580	2480	2680	2010	2470	2970
90	2589	2550	2770	2000	2520	2920
95	2740	2840	2820	1990	2580	2820
100	2920	2740	2800	1990	2650	2770
105	3010	2900	2690	1980	2680	2580
110	2820	3050	2560	1960	2700	2560
115	2770	2930	2410	2000	2650	2430
120	2840	2880	2370	2000	2580	2280
125	3080	2590	2410	1990	2400	2100
130	3250	2650	2550	1960	2220	1970
135	3410	2780	2780	1920	2080	1840
140	3570	2790	3050	1850	1970	1688
145	3140	2820	2720	1500	1780	937
[illegible]	3570	1950	3050	2040	2700	2010
[illegible]	2540	2030	2330	1500	1343	881
[illegible]	2891	2592	2826	1970	2297	2336
[illegible]	45	30	34	423	169	258

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Ｇ０２Ｆ	1/1335	５３０	7408－2K		

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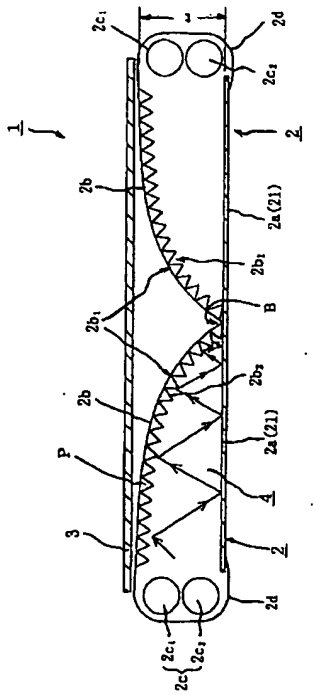
(54)【発明の名称】　中空導光板本体及びそれを用いた中空導光板

(57)【要約】

【目的】　高輝度かつ高均斉度の出光が可能で、軽量な中空導光板本体及びそれを用いた中空導光板を提供するにある。

【構成】　平坦な光反射層(2a)と、一軸方向に滑らかに弯曲した光出射層(2b)とを、該弯曲した軸の一端側では光反射層(2a)と光出射層(2b)とが対向しかつ他端側では光出射層(2b)が光反射層(2a)に接しうるように空気層(4)を介して配置すると共に、上記光反射層(2a)と光出射層(2b)とが対向する側の空気層(4)端部に、上記弯曲した軸を含む面と略垂直な方向で線状に光源(2c)を配置し、上記光出射層(2b)は、外面が平滑面(2b1)で、光反射層(2a)に向かう内面が多数のプリズム体(P)が各主軸を上記弯曲した軸と略直角にして平行に並列配置された連続プリズム凹凸面(2b2)からなる可撓性の透光性シート(22)にて構成する。



【特許請求の範囲】

【請求項１】　平坦な光反射層と、一軸方向に滑らかに弯曲した光出射層とを、該弯曲した軸の一端側では光反射層と光出射層とが対向しかつ他端側では光出射層が光反射層に接しうるように空気層を介して配置すると共に、上記光反射層と光出射層とが対向する側の空気層端部に、上記弯曲した軸を含む面と略垂直な方向で線状に光源を配置してなり、

上記光出射層は、外面が平滑面で、光反射層に向かう内面が多数のプリズム体が各主軸を上記弯曲した軸と略直角にして平行に並列配置された連続プリズム凹凸面からなる可撓性の透光性シートから構成されたことを特徴とする中空導光板本体。

【請求項２】　連続プリズム凹凸面の凸部を構成する各プリズム体の頂角が70～110°である請求項１記載の中空導光板本体。

【請求項３】　光反射層が、光反射シート及び該光反射シートに付される多数の光散乱性ドットによる光散乱層とからなり、光散乱性ドットが光出射層の曲率変化に基づいて分布密度が調節されてなる請求項１又は２記載の中空導光板本体。

【請求項４】　請求項１～３のいずれかに記載の中空導光板本体の２つを、各光源が両端に位置するように左右対称的に配し、各中空導光板本体の光出射層と光反射層との接続線が互いに接触すると共に、各光反射層が同一平面を形成するように連結してなる中空導光板。

【請求項５】　光出射層の外側に光拡散層が光反射層と略平行に配置されてなる請求項４に記載の中空導光板。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、中空導光板本体及びそれを用いた中空導光板に関する。さらに詳しくは、各種面照明装置のバックライト用導光板、ことに液晶を用いたディスプレイ装置に好適なサイドライト方式の中空導光板本体及び中空導光板に関する。

【０００２】

【従来の技術】液晶を用いたディスプレイ装置は、低電力、薄型などに定評があるため、従来の陰極線管に替わるものとして実用化されて来ており、ことに大型の画面表示装置として注目されている。このような液晶ディスプレイ装置では、液晶自体は発光しないため、液晶を背面から照明して可視化させるバックライト用導光板が必要となる。上記導光板には、例えば透光性平板（アクリル板）の側面から光を入射させ、これを大きな平板面から出光させるいわゆるエッジライティングの技術を利用したものが汎用されており、これらは概ね中実体のもので構成されている。

【０００３】ところで、液晶ディスプレイ装置は大型化に向かう傾向にあり、これに伴って導光板も大型のものが要求されるが、大型化に伴い重量が増加するという問題があるが、これに対しては、導光板を中空体に構成することにより軽量化が図られている。この一例として、透光性平板を中空構造体に構成して中空導光板基体とし、この基体の２つの大きな面のうちの一つに光反射層を構成し、他面を出光面としたものが挙げられる。

【０００４】しかしながら、このような中空導光板では、中空導光板基体の出光面側は外面及び内面がいずれも平坦面であって、側端面から導入される光を、光反射層と出光面側内面の平坦面との間での反射及び出光面側での屈折を繰返して、該基体内に導き、出光させるものであるが、導光される光が光源に近いところで基体を透過して出光してしまい導光方向への拡散減衰が生じ、高輝度な出光が望めなく、また輝度ムラも生じる。

【０００５】一方、高輝度な面光源素子としては、例えばサイドライト方式の中実導光板に、一面が平滑な面で他面がプリズム群からなる透光性シートを併用し、この透光性シートの平滑面が上記中実導光板の光出射面に対向するよう配置させたものが知られている（特開平２－８４６１８号公報参照）。しかしながら、上記透光性シートは導光板の構成要素ではなく、また導光板の光出射面と平行に配されて該光出射面からの出射方向を法線方向に変換させるために用いられており、結局、この面光源素子は特定方向のみの視角範囲が高輝度となるものである。

【０００６】

【発明が解決しようとする課題】そこで本発明の解決しようとする課題は、高輝度かつ高均斉度の出光が可能で、軽量な中空導光板本体及びそれを用いた中空導光板を提供するにある。

【０００７】

【課題を解決するための手段】かくして本願『請求項１』にかかる発明によれば、『平坦な光反射層(2a)と、一軸方向に滑らかに弯曲した光出射層(2b)とを、該弯曲した軸の一端側では光反射層(2a)と光出射層(2b)とが対向しかつ他端側では光出射層(2b)が光反射層(2a)に接しうるように空気層(4)を介して配置すると共に、上記光反射層(2a)と光出射層(2b)とが対向する側の空気層端部に、上記弯曲した軸を含む面と略垂直な方向で線状に光源(2c)を配置してなり、上記光出射層(2b)は、外面(2b1)が平滑面で、光反射層(2a)に向かう内面(2b2)が多数のプリズム体(P)が各主軸を上記弯曲した軸と略直角にして平行に並列配置された連続プリズム凹凸面からなる可撓性の透光性シート(22)から構成されたことを特徴とする中空導光板本体(2)』が提供される。

【０００８】本発明の中空導光板本体(2)において、光出射層(2b)は可撓性の透光性シート(22)から構成される。この透光性シート(22)は、一面(2b1)が平滑面で、他面は多数のプリズム体(P)が各主軸を平行に並列配置された連続プリズム凹凸面に構成されたものが用いられ

る。上記透光性シート(22)は、平滑面が導光板本体の外面側に、連続プリズム凹凸面が導光板本体の内側で光反射層(2a)と向き合うように用いられる。さらに上記透光性シート(22)は、一軸方向に滑らかに弯曲して用いられるが、このとき連続プリズム凹凸面の各プリズム体(P)の主軸は弯曲した軸に対して略直角方向に設定される。これによって、線状に配される光源の軸と各プリズムの主軸とが平行又は略捩れ配置となり、光源からの直射光や光反射層(2a)からの反射光を効率よく反射・屈折・透過できることとなる。上記透光性シート(22)としては、強度、透光性及び屈折性等の点からポリカーボネート製のものが好ましく、アクリル共重合樹脂製のものも好適に用いられるが別段これらに限定されない。

【０００９】上記光出射層(2b)は、光源(2c)の近傍すなわち中空導光板本体(2)の一端部では光反射層(2a)と対向し、光源(2c)から遠位になるに連れて光反射層(2a)に向かって滑らかに弯曲され、最終的に光反射層(2a)に接するように配置される。

【００１０】本発明の中空導光板本体(2)においては、光出射層(2b)を構成する上記透光性シート(22)の弯曲部の曲率及び各プリズム体(P)の大きさを調節することにより、光出射量及び光反射量を定量的に制御することができる。

【００１１】上記光出射層(2b)を構成する透光性シート(22)は、本願『請求項２』に示すように、該シートの連続プリズム凹凸面の凸部を構成する各プリズム体の頂角(θ)は、70～110°の範囲に調節されたものが高輝度、高均斉度の点から好ましい。

【００１２】本発明の中空導光板本体(2)において、線状に配置される光源(2c)とは、線状光源を用いてもよくまた点状光源を線状に多数配列したものであってもよい。本発明においては線状光源を用いることが好ましく、蛍光灯や冷陰極放電管等が挙げられ、後者は単位長さ当たりの光量が大であること、殆ど発熱しない等の点からさらに好ましいものである。

【００１３】光反射層(2a)は、当該分野で公知の光反射シートをそのまま用いることができるが、アルミ箔、銀鏡反応等による薄膜等の自由電子を有する反射層は微弱ながらも発熱を伴うので好ましくなく、白色のプラスチックシート(21)が好適に用いられる。光反射層(2a)のより好ましい態様としては、本願『請求項３』に示すように、上記光反射シート(21)と多数の光散乱性ドット(23)による光散乱層(2A)とから構成し、光散乱性ドット(23)を光出射層(2b)の曲率変化に基づいて密度を調節して光反射シートに付したものを挙げることができ、これは高輝度及び高均斉度の点から非常に好ましいものである。上記光散乱層は、透明樹脂に光散乱性の無機物を混入して光散乱性インクを調製し、これを光出射層の曲率等に応じてドットグラデーションパターン印刷したものが好適であるが、これに限定されず、上記ドットグラデーションパターンにおける各光散乱性ドットそのものを、光反射性シートを直接粗面処理して構成することも挙げられる。

【００１４】本願発明はまた、『請求項４』に示すように、上記本願発明の中空導光板本体(2)の２つを、各光源が両端に位置するように左右対称的に配し、各中空導光板本体(2)の光出射層(2b)と光反射層(2a)との接続線が互いに接触すると共に、各光反射層が同一平面を形成するように連結してなる中空導光板(1)を提供することもできる。

【００１５】上記中空導光板(1)において、本願『請求項５』に示すように、光拡散層(3)が、光出射層(2b)の外側でかつ光反射層(2a)と略平行に配置されていてもよい。上記光拡散層としては当該分野で公知のものがそのまま用いられる。

【００１６】

【作用】本願『請求項１』にかかる発明によれば、光源(2c)から照射された光の大部分は、空気層(4)を介して配された光反射層(2a)と光出射層(2b)の連続プリズム凹凸面との間を反射を繰返して導光体内を光源から遠位方向に導かれる。ここで、光源(2c)から水平方向に進む直進光も上記反射光も、空気層(4)中を通過するので、この通過中で光は吸収されなく光量の減衰は生じない。また、光出射層(2b)は光源(2c)から遠位になるほど滑らかに弯曲して空気層(4)を遮るので、直進光は必ずいずれかのプリズム面に入射して屈折・出光されると共に、反射光もこの弯曲に伴って出光が遠位部まで引き伸ばされることとなり、光源近傍での出光が抑制される一方、光源から遠位部での出光量が増えることとなる。

【００１７】本願『請求項２』にかかる発明によれば、連続プリズム凹凸面の凸部を構成する各プリズム体(P)の頂角(θ)が70～110°に設定されているので、遠位部へ導かれる光量が増えると共にさらに均斉化される。

【００１８】本願『請求項３』にかかる発明によれば、光反射層(2a)が、光反射シート(21)及び該光反射シートに付される多数の光散乱性ドット(23)による光散乱層(2A)とからなり、光散乱性ドット(23)の分布が光出射層(2b)の曲率変化に基づいて粗密が調節されているので、光出射層(2b)からの出光がより高度に均斉化されることとなる。

【００１９】本願『請求項４』にかかる発明によれば、請求項１～３のいずれかの中空導光板本体(2)の２つが、同一平面上の光反射層(2a)上に左右対称的に配されているので、各光源近傍部での出光が押さえられると共に、中央部では各中空導光板本体(2)からの出光量が適度に混合されるので、全体的に高均斉化されかつ高輝度になる。

【００２０】本願『請求項５』にかかる発明によれば、光出射層(2b)の外側に光拡散層(3)が光反射層(2a)と略平行に配置されているので、高輝度かつ高均斉度を保持

したまま出光面でのギラツキが防止されることとなる。

【００２１】

【実施例】以下、本発明を図示実施例に従って詳述するが、これによって本発明が限定されるものではない。

実施例１

図１は本発明の中空導光板の一例の断面構成説明図である。同図において、中空導光板(1)は、左右対称的に配置された２つの中空導光板本体(2)(2)と、これらの中空導光板本体の上部に設けられた光拡散板(3)とから主として構成されている。

【００２２】各中空導光板本体(2)は、平板状の光反射層(2a)と、一方向に滑らかに弯曲して降下する光出射層(2b)と、線状光源(2c)と、ランプリフレクタ(2d)とから主として構成されている。

【００２３】光反射層(2a)は、白色のプラスチックシート(21)で構成されており、この例では２つの中空導光板本体(2)に共通な一枚もので構成されている。

【００２４】各光出射層(2b)は、ポリカーボネート製の透光性シートで、外面は平滑面(2b1)であり、内面は多数のプリズム体(P)が各主軸を上記弯曲方向と略直角でかつ並列配置された連続プリズム凹凸面(2b2)からなっている。上記連続プリズム凹凸面における各プリズム体(P)は、図２に示すように各頂角(θ)が、70～110°の範囲となるように設定されている。上記光出射層(2b)と光反射層(2a)とは、空気層(4)を介して配されており、中空導光板本体において一端部では互いに略平行に対向しており、他端部では光出射層(2b)は光反射層(2a)に接触している。そして略平行に対向配置された側の空気層(4)の端部に線状光源(2c)が配置されている。

【００２５】線状光源(2c)は、２本の冷陰極放電管(2c1)(2c2)が用いられており、図面に略垂直方向に配されると共にこれら２つの放電管は図面の上下方向に重なるように配されている。

【００２６】ランプリフレクタ(2d)は、内部に線状光源(2c1)(2c2)を包み、上記光反射層(2a)の端部から光出射層(2b)の端部に亙って設けられている。

【００２７】中空導光板(1)は、各中空導光板本体(2)(2)が、共通の光反射層(2a)上での各光出射層(2b)(2b)の接触端が互いに接触して境界線(B)を形成しうるように配置されている。

【００２８】光拡散板(3)は、当該分野で通常用いられているものと同様のものであり、２つの中空導光板本体(2)(2)の上部でかつ光反射層(2a)と略平行に配されている。

【００２９】上記のように構成された中空導光板(1)は、例えば図３の平面構成説明図に示されるように１対の対向長辺側に線状光源(2c)が配置されたものであり、大きさは図１及び図３におけるＸ＝230㎜，Ｙ＝145㎜，t＝10㎜に設定されているが、これに限定されない。

【００３０】以上の構成において、プリズム体の頂角(θ)をそれぞれ110°，90°，70°に変更する以外は同様の構成である３種の中空導光板(1A)(1B)(1C)を作製し、各中空導光板において図３における中線Ｕ線上の輝度(cd/㎡)を、一方の線状光源から５㎜間隔で測定したところ、図４の表に示す結果を得た。なお、比較例として、平面図における出光面の面積が実施例と同一な中実の導光板で、i)一様な厚さ（t＝10㎜）のもの〔比較例①〕、ii)光出射面が円筒面の一部をなす凹面でこれと対向面が平坦面であるもの（最高厚みt＝10㎜）〔比較例②〕、iii)横断面がクサビ型（最高厚みt＝10㎜）のものを左右対称形に対向連結したもの〔比較例③〕をそれぞれ用意し、各光出射面での輝度を実施例と同様に測定した。結果を図４の表に併せて記す。

【００３１】以上の結果から、本発明の中空導光板(1A)(1B)(1C)ではいずれも、比較例①，②及び③に比して、質量が非常に小さい上、平均輝度が大きく、かつ光出射面全体での均斉化が優れていることが分かる。

【００３２】実施例２

実施例１の中空導光板(1)において、光反射層(2a)の光出射層との対向面に光散乱層(2A)を設ける以外は、これと同様な構成であり、従って同一部材については同一番号で示しこれらについての説明は省略する。光散乱層(2A)は、透明樹脂に光散乱性の無機物粉体（例えばSiO_2）を混入したインクを用いて光散乱性ドット(23)を印刷すると共に、このときに光出射層(2b)の曲率変化に対応してドット分布の粗密を調節したいわゆるドットグラデーション印刷層にて構成されている。上記ドットグラデーション印刷においては、ドット分布が光源側が粗になり光源から遠位になるにつれてすなわち曲率に従って密になるようになされる。

【００３３】以上のような光散乱層を設けることにより、全出射面における輝度がより一層高度に均一化された中空導光板を得ることができた。

【００３４】

【発明の効果】本発明によれば、大きな光射出面を有し、輝度が大きくかつ均一な輝度で出光するサイドライト方式の導光板を提供できる。さらに、大型に構成されても中空構造によって非常に軽量な導光板とすることができる。またさらに、ドットグラデーション印刷による光散乱層を設けたものでは、より高度に輝度均斉化を達成でき、より大型で品質の高いサイドライト方式の導光板を提供できる。

【図面の簡単な説明】

【図１】本発明の中空導光板の断面構成説明図

【図２】図１の要部拡大概略図

【図３】図１の平面構成説明図

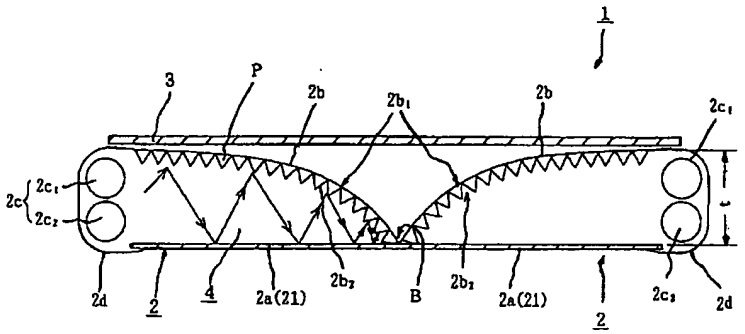
【図４】本発明の中空導光板の光出射面における輝度分布を、比較例と共に示した表

【符号の説明】

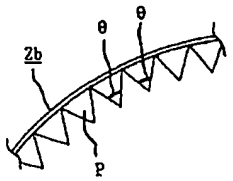
(1)(1A)(1B)(1C)…中空導光板　　(2)…中空導

光板本体
(3)…光拡散板
(4)…空気層
(21)…白色プラスチックシート
シート
(2A)…光散乱層
ム体
(2a)…光反射層
(2b)…光出射
層
(2c)…線状光源
(2d)…ランプ
リフレクタ
(2b1)…平滑面
(2b2)…連続
プリズム凹凸面
(2c1)(2c2)…冷陰極放電管

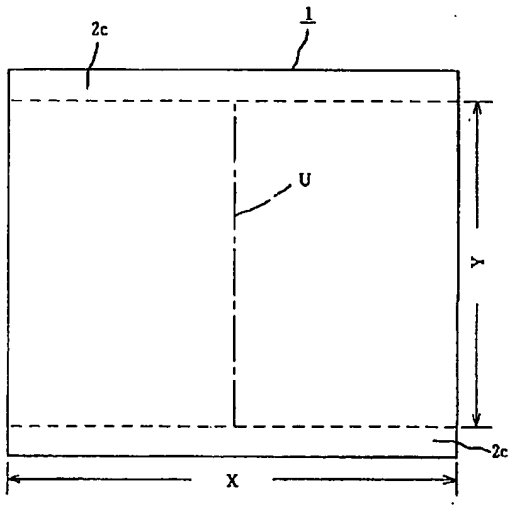
【図１】



【図２】



【図３】



【図４】

U線上での光源からの角度	実施例			比較例		
	1A	1B	1C	①	②	③
5	2940	2060	2580	1610	1243	881
10	3340	2350	2740	1920	1608	1399
15	3150	2160	2500	1990	1730	1705
20	3000	2030	2340	2020	1841	1872
25	2900	2040	2330	2040	1995	1990
30	2800	2140	2360	2040	2150	2160
35	2600	2430	2470	2040	2320	2340
40	2650	2730	2670	2040	2430	2490
45	2920	2860	2810	2030	2500	2620
50	2900	2960	2860	2030	2540	2720
55	2740	2980	2840	2030	2540	2810
60	2570	2890	2790	2040	2520	2880
65	2540	2750	2700	2040	2490	2940
70	2670	2580	2550	2040	2470	2980
75	2710	2380	2470	2030	2440	3010
80	2610	2360	2570	2020	2450	3010
85	2580	2480	2680	2010	2470	2970
90	2580	2550	2770	2000	2520	2920
95	2740	2640	2820	1990	2590	2820
100	2920	2740	2800	1990	2650	2770
105	3010	2900	2690	1990	2690	2680
110	2820	3050	2560	1990	2700	2560
115	2770	2930	2410	2000	2650	2430
120	2940	2680	2370	2000	2560	2260
125	3080	2590	2410	1990	2400	2100
130	3250	2650	2550	1960	2220	1970
135	3410	2730	2790	1920	2080	1840
140	3570	2790	3050	1850	1970	1698
145	3140	2820	2720	1500	1780	937
最高輝度	3570	3050	3050	2040	2700	3010
最低輝度	2540	2030	2330	1500	1243	881
平均輝度	2891	2592	2626	1970	2297	2336
質量	45	38	34	423	199	258

【手続補正書】
【提出日】平成６年３月３１日
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】図面の簡単な説明
【補正方法】変更
【補正内容】
【図面の簡単な説明】
【図１】本発明の中空導光板の断面横成説明図
【図２】図１の要部拡大概略図
【図３】図１の平面構成説明図
【図４】本発明の中空導光板の光出射面における輝度分布を、比較例と共に示した図表
【符号の説明】
（1）（１Ａ）（１Ｂ）（１Ｃ）…中空道光板
（2）…中空導光板本体
（3）…光拡散板　（4）…空気層
（２１）…白色プラスチックシート　（２２）…透光性シート
（２Ａ）…光散乱層　（Ｐ）…プリズム体
（２ａ）…光反射層　（２ｂ）…光出射層
（２ｃ）…線状光源　（２ｄ）…ランプリフレクタ
（２ｂ１）…平滑面　（２ｂ２）…連続プリズム凹凸面
（２ｃ１）（２ｃ２）…冷陰極放電管

フロントページの続き

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